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First Steps in Establishing the NUSC/NAVSEA Video Teleconferencing System

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PREFACE

This document was prepared under NUSC Job Order 701Y03, principal investigator R.G. Heroux (Code 01A3).

The authors appreciate the valuable contributions of J.B. Elwell, project engineer, and J. Merrill who, along with the authors and J.G. Tellier, comprise the NUSC video teleconferencing team.

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19 ABSTRACT (Continue on reverse if necessary and identify by block number)

The initial steps taken by the Naval Underwater Systems Center (NUSC) to bring a three-site video teleconferencing system from the concept stage through approval and design to the stage of user development and incipient use are explained. The video conferencing system, due to be operational in October 1985, will link three sites: NUSC laboratories in Newport, RI, and New London CT, and the Naval Sea Systems Command headquarters in Arlington, VA. This document is intended as a guide to those considering the development of video teleconferencing systems and those planning to submit proposals for such systems.

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INTRODUCTION

The purpose of this document is to explain the initial steps taken by the Naval Underwater Systems Center to bring a three-site, video teleconferencing system for the U.S. Navy from the concept stage through approval and design to the stage of user development and incipient use. As this report is being written, the system is nearing completion. In October 1985, debugging and preliminary testing will be completed, and the system will -- barring unforeseen problems -- be fully operational.

This document is intended as a guide to those, especially in government, considering the development of their own teleconferencing systems and to those planning to submit proposals for such systems. Some of the steps are generic to the realization of any teleconferencing system; some are particular to the U.S. Navy; but similar organizational complexity exists in other government activities and in many private businesses.

In the following pages, four of the key considerations involved in bringing the system to the point of actual use are discussed: (1) approval of authorities, (2) system modularity, (3) security of communications, and (4) user development. The document does not, except incidentally, cover the considerations that went into the design of the system; these will be explained in a future report.

To provide some background, overviews of the organizations to be served by the system and of the system itself are given first.

OVERVIEW OF ORGANIZATIONS TO BE SERVED BY THE SYSTEM

The organizations to be linked by the three-site video teleconferencing system are the Naval Sea Systems Command, headquartered in Arlington, VA, and the Newport, RI, and New London, CT, laboratories of the Naval Underwater Systems Center.

NAVAL UNDERWATER SYSTEMS CENTER (NUSC)

The Naval Underwater Systems Center is one of nine U.S. Navy research, development, test, and evaluation (RDT&E) centers within the laboratory system of the Naval Material Command (NAVMAT).[1] NUSC is the Navy's principal center for submarine warfare and submarine weapon systems. It was formed in 1970 by the merger of the Naval Underwater Weapons Research and Engineering Station in Newport and the Navy Underwater Sound Laboratory in New London. These two locations are now NUSC's principal laboratories.

NUSC also has detachments and field offices in six other locations. These field sites are not discussed in this report since they are not, at present, included in the video teleconferencing system.

The Center employs approximately 3500 people, mostly engineers and scientists, and almost all civilians. Its annual operating budget is more than $500 million. Because many of the Center's projects are worked on jointly by New London and Newport personnel, and because of the administrative complexities engendered by the two geographical locations, a great deal of communication -- requiring many face-to-face meetings and much back-and-forth travel -- occurs between NUSC's New London and Newport laboratories.

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

Money to support the RDT&E programs at NUSC comes primarily from sponsors within NAVMAT located in the Washington, DC, area. The principal NAVMAT sponsor, contributing more than 70 percent of NUSC's funding, is the Naval Sea Systems Command, which is headquartered in the Crystal City complex in Arlington, VA, just outside of Washington.[2]

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[1]Since this report was originally written, the Secretary of the Navy disestablished NAVMAT. NUSC and the eight other RDT&E centers now report to the Chief of Naval Research via the Director of Navy Laboratories. These centers will ultimately be a part of an expanded video teleconferencing network.

[2]NAVSEA, which now comes under the Chief of Naval Operations, continues to be NUSC's principal sponsor.

NAVSEA's primary functions include material support for most shipborne components and systems; ship systems integration and coordination; administration technical support, and guidance; coordination of shipbuilding, conversion, and repair; nuclear propulsion; and salvage and diving operations.

NUSC/NAVSEA COMMUNICATION

Considerable communication concerning ongoing and planned projects occurs between NUSC and NAVSEA. This communication often requires personnel to travel, both between NUSC sites and between NUSC and NAVSEA. NUSC's Newport and New London laboratories are 60 miles apart (1 hour and 20 minutes driving time). Each laboratory is approximately 2.5 hours one way from NAVSEA, including flying time and travel time to airports. On average, 6000 round trips take place yearly between New London and Newport. Approximately 4800 trips are made yearly from NUSC to Washington, DC, with the majority of them to NAVSEA. Additionally, NAVSEA and other Navy personnel from Washington make a number of trips to Newport and New London to visit NUSC, other Navy installations, and contractors in the area.

A great many of the trips between the NUSC locations, as well as those to NAVSEA, involve meetings that occupy only a part of a day. The cost of such travel is considerable -- in dollars, in productive hours, and in wear and tear on the repeat traveler.

VIDEO TELECONFERENCING SYSTEM OVERVIEW

COMSAT General Corporation of Washington, DC, is designing and building the system under a competitively awarded contract.

The system will consist of three physically and electronically secure, modular structures -- one at NUSC Newport, one at NUSC New London, and one at NAVSEA. Those at NUSC will stand alone on concrete pads; the one at NAVSEA will be located in an existing Crystal City Building (National Center 3).

Each site will be capable of full-motion, interactive, encrypted, color video conferencing with either of the other two sites. So, for instance, NUSC Newport will be able to communicate via full-motion video with either NUSC New London or NAVSEA. The capability will also exist to bridge other sites into a meeting by two-way audio. Almost all of the equipment in the system will be off-the-shelf. Although the system is currently configured for point-to-point use, a multipoint operation is being planned that would include other Navy and Department of Defense (DoD) activities and DoD contractors.

AT&T Communications will provide, under competitively awarded contracts, telecommunication between the sites. Full-duplex, dedicated 1.544 megabits/second terrestrial links will be used. The coders/decoders (codecs), supplied through COMSAT, will be from Compression Laboratories, Inc. (CLI).

Figure 1 shows the configuration of the NUSC teleconferencing sites, together with some of their capabilities. Each site will contain a 12-seat conference table and raised gallery seating for 12 other people. More gallery seats can be added if necessary. The NAVSEA conference site will be similar to those at NUSC except that it will not have a distinct gallery, though there will be room for seating behind the conference table.

The two side-by-side screens in front will be able to display six participants in continuous presence, three per screen. If 12 people are seated at the table, either the middle six or the three at each end of the table will appear together on screen. Either of these two camera shots, as with all of the options available to the meeting moderator, will be programmed into the software-driven control system and will be selectable from a menu on one of two touch control panels.

In addition to the people pictures, each site will be able to receive/transmit graphics (transparencies, 35-mm slides, computer-generated materials) and video tapes. Incoming/outgoing graphics will be displayed on a separate screen centered above the ones showing the conference participants. At both NUSC and NAVSEA, the system will be connected to the local area networks (LANS) by IBM microcomputers so that data can be brought in from or sent to other computers and so that voice and video images can be broadcast to or from locations outside the conference areas.

All three sites are also designed to permit stand-up presentations from a podium, in addition to sit-down meetings, with audio and visual interaction possible between the presenter and those at the remote site.

The system will accommodate meetings, courses (live or on videotape), and briefings. Ultimately, it may also receive courses broadcast from sites not part of the NUSC/NAVSEA system.

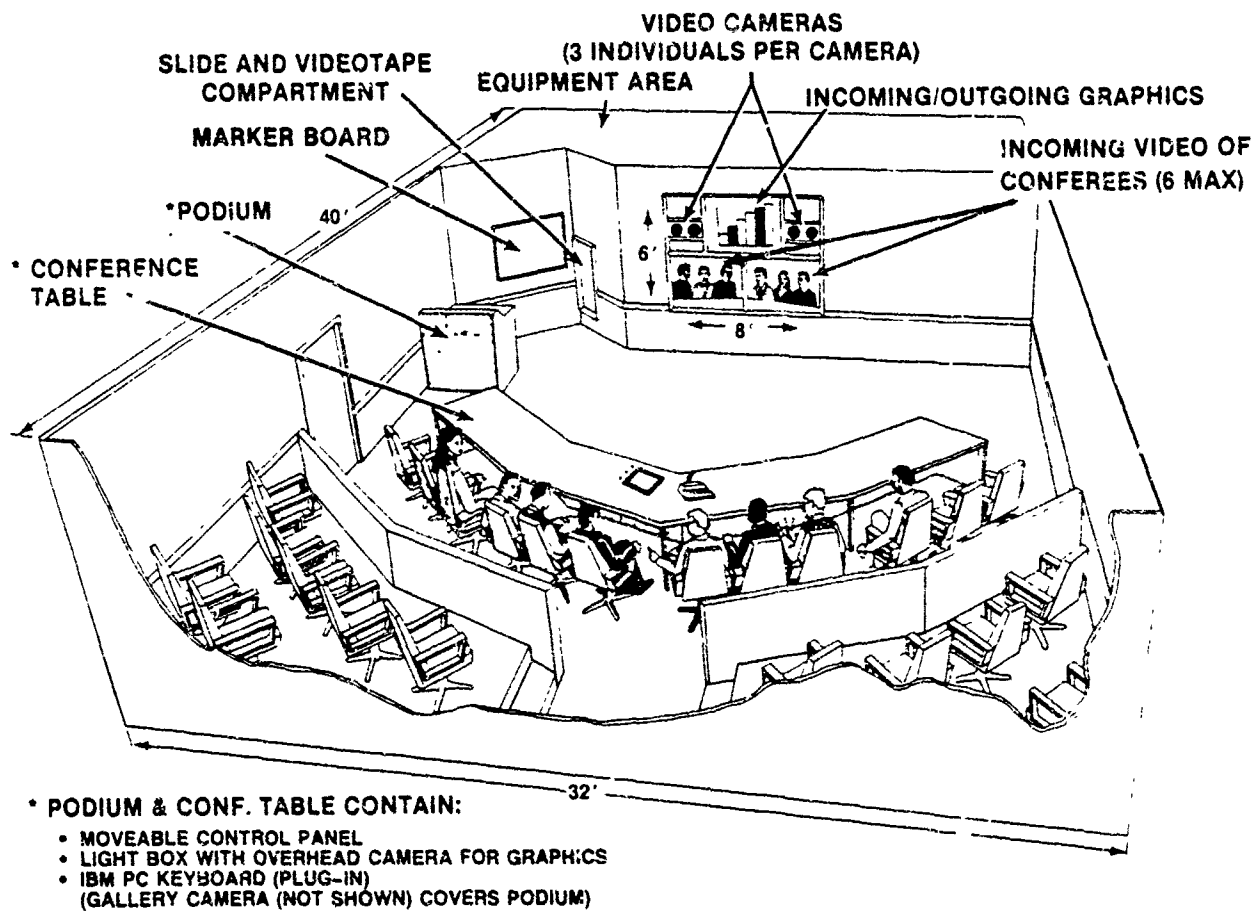

Figure 1. NUSC/NAVSEA Video Teleconferencing System

KEY CONSIDERATIONS IN SYSTEM REALIZATION

SECURING NECESSARY APPROVALS

The approvals necessary for realization of this video teleconferencing system were numerous and complex. A number of organizations outside of NUSC, and with jurisdiction over it or over various components of the proposed system, had to be involved. In addition to formal approvals, the cooperation of other organizations was important.

The NUSC/NAVSEA 1.544-megabits/second, secure video teleconferencing system is a first for the Navy. Moreover, it consists of a combination of technologies that, traditionally, fall under separate organizational entities in the Navy -- audio visuals and television, telecommunications, and data and office automation. No central approval authority exists in either the Navy or DoD as a whole to deal specifically with video teleconferencing. Nor are there, at present, any Federal Government standards on teleconferencing.[3]

Seeking approvals, consequently, did not simply involve formal requests. The Project Manager, at each step of the approval process, had to explain all aspects of the system, as well as justify its implementation. As one indication of the success of this effort, the Navy Laboratories Technical Office Automation and Communication System (NALTOACS) has designated the NUSC/NAVSEA teleconferencing system as a demonstration project for the laboratories that fall under the Director of Navy Laboratories, a division of NAVMAT. Thus, NUSC/NAVSEA is taking a lead role in establishing future Navy teleconferencing policy and planning.

The various approvals can be categorized, with some overlap, into those associated with NUSC management, those involving NAVSEA, and those needed from other Navy groups.

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[3]The National Communications System (NCS), as part of its directive from the Office of Science and Technology Policy, is currently studying the development of teleconferencing standards in cooperation with other Federal and industrial standards committees and organizations. NCS is a confederation of Federal Government departments and agencies established by Presidential memorandum in 1963 to provide a centrally planned, programmed, and operational Federal Government telecommunications system. The Secretary of Defense serves as executive agent of NCS and the Director of the Defense Communications Agency (DCA) serves as its day-to-day manager.

NUSC Approval

Ever since the 1970 merger that founded NUSC, teleconferencing of one form or another, along with various modes of transportation, has been considered as a way to alleviate travel and communications problems To a lesser degree, teleconferencing has also been looked at as a way to get maximum benefit from in-house courses and guest lecturers and to more efficiently coordinate briefings to or from visitors at NUSC. But it is only within the last 3 years or so that the right combination of circumstances has occurred to allow a suitable teleconferencing system to become a practical reality. These circumstances include: wider availability of digital transmission systems; lowered telecommunications costs resulting from the development of video codecs (particularly at rates of 1.544 megabits/second and below); the ability to integrate encryption equipment with these codecs; business and industry success with video teleconferencing; available funding; and management support.[4]

As is typically the case with the development of teleconferencing in any organization, the support of top management at NUSC has been essential to the current project. In 1982, a small group of people was tasked by NUSC's then Deputy Technical Director, E.L. Messere, to study the feasibility of teleconferencing. The study group also had the support of the then Commanding Officer, Capt J.W. Ailes, IV, the chief military authority at NUSC. Mr. Messere, shortly thereafter, became Technical Director, the chief civilian manager at NUSC. If either of these people had not been favorable to teleconferencing, the project would not have moved beyond the study phase.

The Technical Director and the Commanding Officer were not the only ones who had to support the project. NUSC is organized into technical (product line) departments and support departments that function autonomously in many ways. From a user perspective the support of both types of department was needed for the system to be utilized effectively.

The project team reported back in May 1983 with a recommendation to construct a full-motion video teleconferencing system to connect the two NUSC laboratories and NAVSEA. Before and during the preparation of its report, the team had a considerable amount of formal and informal communication with NUSC management, including taking them on site visits, so that top management would be well informed about the various types of teleconferencing systems. The team was aware, as a result, that management did not view freeze frame or audiographic teleconferencing as suitable to NUSC's immediate needs, even though management knew of their financial advantages over full-motion video.

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[4] A good summary of business and industry experience with video teleconferencing can be found in Kathleen J. Hansell and David Green, "Videoconferencing in American Business: Perceptions of Benefit by Users of Intra-Company Systems," Teleconferencing and Electronic Communications: Applications, Technologies and Human Factors, compiled by Lorne A. Parker and Christine H. Olgren, University of Wisconsin-Extension, Center for Interactive Programs, 1982, pp 315-327.

The project team also benefited from the suggestions of teleconferencing consultants, including the Center for Interactive Programs (CIP) at the University of Wisconsin. Dr. Lorne Parker, Director of CIP, provided considerable assistance to the team while on an intermittent Intergovernmental Personnel Act (IPA) assignment to NUSC.[5]

A key event in convincing management to accept the project team's recommendation was a visit to Aetna Life & Casualty in Hartford, CT. In its downtown Hartford facility, Aetna has several video teleconferencing rooms that can be interconnected for demonstrations. A group of NUSC's top management was brought to Hartford. Half sat in one room with the Technical Director; half in another with the Commanding Officer. The two rooms were linked and, within minutes of the conclusion of this ad hoc meeting, a decision was reached to proceed with the system.[6]

The next step was the creation and in-house advertisement of the position of project manager. This position, currently occupied by R.G. Heroux, was placed under the Deputy Technical Director so it would have direct access to top management and high visibility within the NUSC organization. The project was given an operating budget and permission to draw, as needed, on other NUSC personnel, with department head concurrence, to accomplish the task of building the system.

The NUSC video teleconferencing project team consists of the project manager and a project engineer, both full time, and three other people who work part to full time, as needed. A number of other NUSC personnel have contributed, at various stages, to contract specifications, proposal evaluations, and system design.[7]

NAVSEA Approval

NAVSEA management also strongly supports the video teleconferencing project. Responsibility for it within the NAVSEA organization falls under the Information Systems Improvement Project (PMS-309).

NAVSEA is providing its share of space, financing, and personnel. It sees this support as a wise investment in long-range planning since it is likely that other NAVSEA-funded laboratories and NAVSEA-directed activities, such as shipyards, will install video teleconferencing systems. Moreover, once the NUSC/NAVSEA system is

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[5]For information on Intergovernmental Personnel Act (IPA) assignments, contact J.F. Griffin, Office of Research and Technology Applications, Naval Underwater Systems Center, New London, CT 06320, Tel: (203) 440-4116.

[6]The NUSC/NAVSEA project owes a debt of gratitude to Aetna Life & Casualty, especially to Richard M. O'Keefe, C. Marc Powell, and Rozanne M. Brand of the Corporate Communications Department. By hosting the visit of NUSC management, by hosting other visits by the NUSC project team, and by providing invaluable advice, Aetna served as a catalyst in the realization of the NUSC/NAVSEA video teleconferencing system.

[7]In particular, J.H. Camisa of the Facilities Department and W.B. Waters (RMCS, Ret) of the Command Support Department made key contributions.

operational, and the demands on it determined, it is anticipated that NAVSEA will use it to communicate with other Navy activities in the Newport/New London areas.

Other Navy Approvals

Since NUSC is taking the lead on the project and since the approvals which it sought also apply, for the most part, to NAVSEA, only those approvals which NUSC had to secure are covered here.

Once NUSC's management committed itself to support the system, NAVMAT, the parent command, had to approve of the project and of NUSC's spending capital equipment funds to build the system. Once this overall authorization was granted, parallel approval processes occurred in three areas; concrete pads at the NUSC sites; telecommunications links; and system design and function.

Three sets of initial documents were needed to cover these three areas: one request for proposals (RFP) for the teleconferencing system; two distinct contract actions for the pads; two telecommunication service requests (TSRs) for the telecommunications links. Each of the three sets had to go through separate approval chains and had to be issued by separate Navy activities. The TSRs, in addition to requiring Navy approval, had to be approved and issued by a separate DoD activity, the Defense Commercial Communications Office (DECCO). NUSC prepared the specifications for each of the sets of documents and participated, in varying degrees, in each of the evaluation sessions held prior to contract award.

The NUSC video teleconferencing team was most thoroughly involved, as a group, in the preparation of the RFP for the video teleconferencing system itself. The RFP was very detailed, reflecting the project team's analysis of the applications of the system and of the "corporate culture" of NUSC and NAVSEA. The RFP was reviewed, approved, and announced in the Commerce Business Daily in January 1984, by the Navy Regional Contracting Center Detachment (NRCCD).

After the RFP was issued in March 1984, a preproposal conference of potential bidders was held in April. This conference included a visit to the NAVSEA and NUSC sites. Based on the comments and questions of those attending the bidders' conference, NRCCD amended the RFP. Other amendments also followed due, mainly, to fiscal matters internal to NUSC.

The proposals were received in May 1984 and evaluated during the summer. The award to COMSAT General was announced in September of 1984 -- 15 months after the study group reported back its recommendation for a three-node, full-motion system to the Technical Director.

SYSTEM MODULARITY

The NUSC/NAVSEA teleconferencing system will consist of three secure, modular structures. Each structure can, if desired, be dismantled and moved to another site. Though the system is not, in any sense, portable, the potential flexibility in location of the modules is seen as a positive benefit for future facilities planning at both NUSC and NAVSEA.

This flexibility, however, was not the primary reason for selecting modularity. Careful examination at both Newport and New London indicated that existing conference rooms should not be adapted for video teleconferencing. Meeting space at NUSC is at a premium. Conversion of an existing room would have meant either dedicating that room to video conferencing, thus taking it off the list of rooms available for face-to-face meetings, or pitting teleconferencing and live meetings in head-to-head competition on a reservation schedule. Both approaches were seen as undesirable because they could lead to negative attitudes toward the system.

Several NUSC buildings were considered for retrofitting. But the large support columns in these buildings would have hindered the flexibility of system design. Retrofitting would also have proven costly and would have delayed the project as much as six months to a year. Such a delay, along with potential changes in management anywhere along the approval cycle, could have seriously affected the planning and the fiscal priorities necessary to build the system.

Human factors considerations were also important to this analysis. The Technical Director had indicated that one criterion he would use to measure the success of the system would be its acceptance and use by NUSC personnel as an effective communication tool for accomplishing their work. The project team, moreover, did not want the system to be viewed as designed for and available to only a few. Locating the system in existing NUSC buildings, especially those housing top management, could have led to this impression. Management agreed with this assessment, and the decision was made to use modular structures and to place them as centrally as possible at both NUSC sites. The NAVSEA site will also be centrally located.

COMMUNICATIONS SECURITY

The two questions most commonly asked at NUSC by those with a strong need for the system are "When will it be ready?" and "Will it be secure?" Discussion of classified matters occurs frequently enough within NUSC and between NUSC and NAVSEA that the usefulness of the system would have been greatly reduced if it did not permit such conversations. NAVSEA, in fact, would not have supported its node at all if communications could not be encrypted.

The task of providing secure communications has required the close cooperation of various parties to plan, make, and test the interconnections and to provide the necessary equipment and expertise.

Besides the security offices at each of three system sites, the major organizations involved with installation, testing, and approval of the system from a security point of view included the Naval Electronics Systems Security Engineering Center, the Naval Electronics Systems Engineering Center, and the National Security Agency.

USER DEVELOPMENT

The NUSC project team has been very conscious from the outset of the project that potential users of the system need to be cultivated. The team has the advantage of knowing, from the experience of those who have implemented other teleconferencing systems, that the following statements are true: No matter how valuable the system might be in principle, no matter how sophisticated its capabilities, people will not come thronging to it as soon as the doors are open. Rather, they must be made aware of the system, its applications, its benefits, and its limitations, and they must be oriented to using it effectively and comfortably. This process of user development, moreover, must be continual, not occurring only while the system is new.[8]

Concern for the user began even before NUSC management approved of the system. Even though the need for teleconferencing was evident, an informal needs assessment was carried out, before and after this approval, to identify applications of the system and groups of likely users. Travel records were examined as a part of this process.

Two groups emerged immediately from this examination. One was NUSC's department heads, who meet weekly. To reduce the number of people who have to travel, department head meetings are held in New London on Wednesdays and in Newport on Thursdays. Inevitably, discussions of likely interest to all department heads occur at one meeting but not the other. Only one weekly meeting will be needed once the system is operational.

A second group consisted of many people from several departments who work on a large ongoing program. Key people in this program travel frequently between the two NUSC sites and to NAVSEA, and they eagerly await the availability of the video teleconferencing system; some of the personnel in this program provided valuable input to the project team in developing the RFP and evaluating proposals.

Meetings of both the department heads and of the personnel in this large program typically include up to 12 people of equal importance per location. This fact determined the specification in the RFP of table seating for 12 participants per site.

Continuing such needs assessment is one component of the user development plan. The plan consists of three main thrusts:

- Cultivation and orientation of users, especially initial users
- System promotion
- System support

The process will occur at both NUSC and NAVSEA. Since the NUSC/NAVSEA link will be operational about 2 months after the intra-NUSC link, the NUSC team will be able to assist NAVSEA at every stage.

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[8]Much has been written on the topic of user development. One good summary source is "Implementation: The Soft Side of Doing It Well," Chapter 5 in Robert Johansen, Teleconferencing and Beyond: Communications in the Office of the Future, McGraw-Hill, New York, 1984, pp 71-88.

Cultivation and Orientation of Users

The experience of initial users can be crucial to the success of the system since they will share their experiences, good and bad, with others. The project team is, consequently, making a concentrated effort to cultivate, as the first users of the system, a certain type of person. The department heads and the program personnel just discussed fall into this category.

Beyond these two groups, NUSC managers have been asked to identify personnel in their line organizations who meet the following criteria:

1. Employees who travel or communicate frequently between the two NUSC laboratories or between NUSC and NAVSEA (especially those who will be doing so during the first 3 months of the system's operation).

2. Employees who find it difficult to perform their jobs effectively because of the demands of such travel and communication.

3. Employees who see the NUSC/NAVSEA teleconferencing system in a positive light.

4. Employees who serve as role models for others in adopting innovations.[9]

Members of the project team will meet with as many of these potential users as possible, either individually or in groups, to explain the capabilities of the system and to ask how it might best meet their communications needs. Then, team members will familiarize these individuals with the system's operation and jointly plan for their first real use of the system. Since these users will likely have concerns about the system or their performance on it, this first use should not be for an important meeting. Rather, it might be, for example, a planning session for an upcoming meeting. During this first use, and subsequent ones as necessary, a member of the project team will be available to assist the participants.

Cultivation and orientation of later users will follow a similar pattern with, it is hoped, the informal assistance of initial users who have had successful experiences with the system.

As part of the ongoing plan, those using the system will be asked to complete brief evaluation forms. Records of system use will also be maintained. This information will be analyzed to determine ways the system might be adapted, in areas such as equipment and scheduling, to meet the continually developing and changing needs of the user.

[9]For an essential summary of research on diffusion of innovations and the categories of adopters of innovations, see Everett M. Rogers, Diffusion of Innovations, Third Edition, The Free Press, New York, 1982.

System Promotion

Publicity of the system will be designed to make people aware of its existence, its applications and, importantly, its benefits and availability.

The early stages of publicity have included articles in NUSC's in-house newspaper and, at every opportunity, informal conversations by members of the project team with anyone who seems to be a likely candidate to use the system. Thus far, most potential users appear to be enthusiastic.

It is planned to use a variety of avenues to publicize the system, including additional articles, posters, briefings, and videotapes.[10]

System Support

System support exists for the user and, so, is part of the user development plan. Three key elements make up this support -- coordinators, scheduling, and system reliability.

Coordinators. Each site will have a full-time coordinator to give tours, answer questions, orient users to the system, conduct evaluation interviews, maintain records of system use, and do basic troubleshooting.

Scheduling. Reservations to use the system will be made through the coordinators, who will ultimately use a computer-based system. The amount of time that can be reserved has yet to be decided. The initial decision will probably be largely arbitrary and, then, modified in light of data on system use. Though the lengths of current face-to-face meetings of different types can be determined, teleconference meetings may be shorter if it holds true that they are more efficient than live meetings.

Initially, there will be a period of 30 minutes between meetings to permit orderly transitions. The length of this transition period may be reduced if experience shows that less time is needed. The system will also have a built-in time-down clock. Messages as to time remaining will be superimposed on the screen and, at the end of the reserved time, the system will shut down.

One of the key issues people have brought up is whether they will be "bumped" even though they have made a reservation to use the system. Loss of user confidence in being able to schedule time on the system could ultimately lead to fewer users. The plan is that a "no-bump" reservation system will be in effect. It is also planned to have the system available for extended operating hours, say from 6:00 a.m. to 6:00 p.m. Moreover, serious consideration is being given to reserving two time blocks a day for emergency meetings -- one in the morning and one in the afternoon. All the plans made and reassurances provided will not, however, alleviate the understandable emotional concern about being bumped. As with other aspects of system use, only people's experiences will tell.

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[10] A good source of practical advice and examples of approaches to publicity for any teleconferencing system is American Telephone and Telegraph Co.'s Audiographics Teleconferencing Manager's Guide, 1983. AT&T service representatives can be contacted for information on how to purchase this book.

System Reliability. System reliability is another such aspect. If system operation is not dependable, people may be discouraged from using the system. The project team is taking two approaches in this area. One will be a preventive maintenance plan to be carried out either by the Navy itself or under contract. The other will be a contingency plan that will allow smooth transitions from optimum system operation through various stages of limited operation, depending on which components fail and the time it takes to repair or replace them. This contingency plan will be based on an Integrated Logistics Support Plan (ILSP) provided by COMSAT under the contract. The ILSP will spell out such things as the best method of maintaining the system on line, including the mean times between failure of equipment and parts, and which of them to have on hand as spares.

CONCLUSION

A cliche states that the first steps are the hardest. At this point, although the project team knows how challenging these first steps have been, it does not know if those involving actual system use and growth will be more difficult. In looking forward to these steps, team members believe that the future success of the system will hinge on three factors:

- Continuing management support (financial and moral)
- A sound technical system (based on practically all off-the-shelf equipment and on a solid maintenance plan)
- User satisfaction (based on continual support, development of applications, and ongoing evaluation).

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